CLAIMS

1. An angular velocity detector comprising:

a substrate;

support portions formed on a surface of said substrate;

resilient support bodies having their respective one ends connected to said support portions;

at least one vibrator supported to respective other ends of said resilient support bodies while poised above the surface of said substrate at a certain spacing therefrom, the vibrator being capable of being displaced relative to said substrate;

exciting means for exciting said vibrator to vibrate in a certain direction of vibrations; and

displacement detection means which, when an angular velocity acts from the outside while the vibrator is being vibrated in the direction of vibrations by the exciting means, detects a displacement of said vibrator in a direction perpendicular to the direction of vibrations in response to the angular velocity;

wherein said vibrator or an angular velocity detection portion including said vibrator is electromagnetically driven to vibrate.

2. An angular velocity detector as set forth in claim 1, further comprising:

a detection electrode mounted on the opposite side of a space from said vibrator; and

a second substrate located opposite to the first-mentioned substrate, said detection electrode being formed on said second substrate.

3. An angular velocity detector as set forth in claim 1, wherein said at least one vibrator consists of a single vibrator, and wherein said plural resilient support bodies are disposed from outer fringes of said vibrator.

4. An angular velocity detector as set forth in claim 1, wherein said at least one vibrator consists of a single vibrator consisting of an annular thin film and driven to be rotationally vibrated about a center axis of the vibrator.

5. An angular velocity detector as set forth in claim 4, wherein said at least one vibrator consists of a single vibrator made of an annular thin film, and wherein said resilient support bodies consist of plural outer resilient support bodies connected to outer fringes of said vibrator and plural inner resilient support bodies connected to inner fringes of said vibrator.

6. An angular velocity detector as set forth in claim 1, wherein

(A) said at least one vibrator consists of plural vibrators,

(B) said plural resilient support bodies are disposed from outer fringes of each of said vibrators, and

(C) a portion between said vibrators is supported by the

resilient support bodies poised above said substrate.

7. An angular velocity detector as set forth in claim 6, wherein said at least one vibrator consists of two vibrators, and wherein when said vibrators are electromagnetically driven as described above, the vibrators vibrate with a phase difference of 180° with each other.

8. An angular velocity detector as set forth in claim 1, wherein each of said resilient support bodies consists of a linear body or has at least one constriction.

9. An angular velocity detector as set forth in claim 1, wherein said exciting means excites said vibrator and an angular velocity detection portion including said vibrator by electromagnetically driving it and has electrodes disposed in parts of said resilient support bodies and said vibrator to permit said exciting means to electromagnetically drive said vibrator and said angular velocity detection portion.

10. An angular velocity detector as set forth in claim 1, wherein a dug portion is formed in the first substrate at least on a side of said vibrator.

11. An angular velocity detector as set forth in claim 10, wherein said dug portion is formed in a position opposite to said vibrator.

12. An angular velocity detector as set forth in claim 1, wherein said exciting means has a magnet for producing an electromagnetic force when said vibrator or angular velocity

detection portion is electromagnetically driven as described above, and wherein said magnet is disposed immediately above or below said vibrator or said angular velocity detection portion including said vibrator.

13. An angular velocity detector as set forth in claim 12, wherein said magnet is disposed inside said substrate.

14. An angular velocity detector as set forth in claim 12, wherein said magnet is disposed inside a dug portion formed in said substrate at a position located opposite to said vibrator on a side of said vibrator.

15. An angular velocity detector as set forth in claim 12, wherein said magnet is disposed inside a dug portion which is formed in said substrate at a position opposite to said vibrator and which extends through said substrate.

16. An angular velocity detector as set forth in claim 12, wherein said magnet is formed on or in a third substrate different from the first-mentioned substrate and disposed in a dug portion which is formed in the first-mentioned substrate at a position opposite to said vibrator and which extends through the first-mentioned substrate, and wherein the first-mentioned substrate and said third substrate have been bonded together.

17. An angular velocity detector as set forth in claim 16, wherein said magnet is disposed in a dug portion formed in said third substrate.

18. An angular velocity detector as set forth in claim 1, wherein electromagnetically driving said vibrator or angular velocity detection portion including the vibrator as described above is carried out by energizing electrodes disposed on parts of said resilient support bodies and of said vibrators with an AC current to vibrate said vibrator perpendicularly to a line of magnetic force produced by a magnet disposed above and/or below said vibrator or the angular velocity detection portion including said vibrator.

19. An angular velocity detector as set forth in claim 1, wherein said displacement detection means is made of electrodes located on opposite sides of a space, and wherein said electrodes disposed in said vibrator are formed inside a dug portion formed in said vibrator.

20. An angular velocity detector as set forth in claim 19, wherein said electrodes disposed in said vibrator are formed inside said dug portion rather than on a surface of said vibrator.

21. An angular velocity detector as set forth in claim 19, wherein said resilient support bodies are formed such that surfaces of said electrodes disposed on said resilient support bodies are located on a side of said substrate rather than a surface of said vibrator.

22. An angular velocity detector as set forth in claim 20, wherein said resilient support bodies are formed such that

surfaces of said electrodes disposed on said resilient support bodies are located on a side of said substrate rather than a surface of said vibrator.

23. A method of detecting an angular velocity by an angular velocity detector having:

a substrate;

support portions fixedly mounted to a surface of said substrate;

resilient support bodies each having a first end connected to said support portion;

a vibrator supported to a second end of each of said resilient support bodies while poised above the surface of said substrate at a certain distance therefrom, the vibrator being capable of being displaced relative to said substrate;

exciting means for vibrating said vibrator in a certain direction of vibrations; and

displacement detection means for detecting a displacement of said vibrator in a direction perpendicular to the direction of vibrations in response to an angular velocity when said angular velocity acts from the outside while said vibrator is being vibrated in said direction of vibrations by said exciting means;

said method comprising the steps of:

electromagnetically driving said vibrator or an angular velocity detection portion including said vibrator to vibrate;

and

detecting a displacement of said vibrator in response to an angular velocity in a direction perpendicular to the direction of vibrations by said displacement detection means when said angular velocity acts on said vibrating vibrator from the outside.

24. A method of fabricating an angular velocity detector, comprising the steps of:

forming a silicon layer over a first substrate via an insulator layer;

forming a driver electrode and a detection electrode over the silicon layer via an insulator layer, the driver electrode acting to excite a vibrator to vibrate, the detection electrode acting to detect a displacement of the vibrator;

forming the vibrator, plural outer resilient support bodies, outer support portions, plural inner resilient bodies, and inner support portions using said silicon layer, said vibrator being made of an annular thin film, said outer resilient support bodies having their respective one ends connected to an outside of said vibrator, respective other ends of said outer resilient support bodies being connected and supported to said outer support portions, said inner resilient support bodies having their respective one ends connected to an inside of the vibrator, respective other ends of said inner resilient support bodies being connected and supported to said

inner support portions;

removing said insulator layers in such a way that (a) respective one ends of said outer resilient support bodies are supported by said outer support portions, (b) respective one ends of said inner resilient support bodies are supported by said inner support portions, and (c) said outer resilient support bodies, said vibrator, and said inner resilient support bodies are poised above said first substrate;

forming electrodes on a second substrate in a position opposite to said driver electrode and said detection electrode disposed on said vibrator;

bonding together said first and second substrates such that said electrodes are placed in positions opposite to said driver electrode and said detection electrode; and

disposing a magnet as the exciting means on or in at least one of said first and second substrates.

25. A method of fabricating an angular velocity detector as set forth in claim 24, further including the step of forming a dug portion in said first substrate at least on a side of said vibrator.

26. A method of fabricating an angular velocity detector as set forth in claim 25, wherein said dug portion is formed in a position opposite to said vibrator.

27. A method of fabricating an angular velocity detector as set forth in claim 24, wherein said magnet is disposed

immediately above or below said vibrator or said angular velocity detection portion including said vibrator with a space therebetween.

28. A method of fabricating an angular velocity detector as set forth in claim 24, wherein said magnet is disposed inside said substrate.

29. A method of fabricating an angular velocity detector as set forth in claim 24, further including the step of forming a dug portion in said substrate at least a side of said vibrator and disposing said magnet inside said dug portion.

30. A method of fabricating an angular velocity detector as set forth in claim 24, further including the steps of:

forming a dug portion extending through said substrate such that the dug portion is located in a position on said substrate opposite to said vibrator; and

disposing said magnet inside said dug portion.

31. A method of fabricating an angular velocity detector as set forth in claim 24, further including the steps of:

forming a dug portion extending through said substrate such that the dug portion is located in a position on said substrate opposite to said vibrator;

forming said magnet on or in a third substrate different from the aforementioned substrates;

then disposing the magnet, formed on or in the third substrate, inside said dug portion; and

then bonding together the aforementioned substrates and said third substrate.

32. An angular velocity detector as set forth in claim 31, wherein the magnet formed on or in the third substrate is disposed in the dug portion formed in the third substrate.

33. A method of fabricating an angular velocity detector as set forth in claim 24, wherein said displacement detection means is fabricated from electrodes located on opposite sides of a space, and wherein said electrodes disposed on said vibrator are formed within the dug portion via said insulator film after forming the dug portion in said vibrator.

34. A method of fabricating an angular velocity detector as set forth in claim 33, wherein said electrodes disposed on said vibrator are formed inside said dug portion rather than on a surface of said vibrator.

35. A method of fabricating an angular velocity detector as set forth in claim 24, wherein said displacement detection means is fabricated from electrodes located on opposite sides of a space, and wherein said resilient support bodies are so formed that surfaces of said electrodes disposed on said resilient support bodies are located on a side of said substrate rather than on a surface of said vibrator.

36. A method of fabricating an angular velocity detector, comprising the steps of:

forming a silicon layer over a first substrate via an

insulator layer;

forming a driver electrode and a detection electrode over the silicon layer via an insulator film, the driver electrode acting to excite a vibrator to vibrate, the detection electrode acting to detect a displacement of the vibrator;

forming the vibrator and resilient support bodies using said silicon layer, said resilient support bodies acting to poise said vibrator;

forming support portions from said insulator layer, said support portions supporting end portions of said resilient support bodies on an opposite side of end portions which support said vibrator;

removing said insulator layer such that said resilient support bodies and said vibrator are poised above said first substrate;

forming electrodes on the second substrate, said third electrodes being located in positions opposite to said driver electrode and said detection electrode disposed on said vibrator;

bonding together said first and second substrates such that said electrodes are disposed in their respective opposite positions on said driver electrode and on said detection electrode; and

disposing a magnet as exciting means on or in at least one of said first and second substrates.

37. A method of fabricating an angular velocity detector as set forth in claim 36, wherein a dug portion is formed in said first substrate at least on a side of said vibrator.

38. A method of fabricating an angular velocity detector as set forth in claim 37, wherein said dug portion is formed in a position opposite to said vibrator.

39. A method of fabricating an angular velocity detector as set forth in claim 36, wherein said magnet is disposed immediately above or below said vibrator or said angular velocity detection portion including said vibrator with a space therebetween.

40. A method of fabricating an angular velocity detector as set forth in claim 36, wherein said magnet is disposed inside said substrate.

41. A method of fabricating an angular velocity detector as set forth in claim 36, wherein a dug portion is formed in said substrate at least on a side of said vibrator, and wherein said magnet is disposed inside said dug portion.

42. A method of fabricating an angular velocity detector as set forth in claim 36, wherein a dug portion extending through said substrate is formed in a position on said substrate opposite to said vibrator, and wherein said magnet is disposed inside said dug portion.

43. A method of fabricating an angular velocity detector as set forth in claim 36, further including the steps of:

forming dug portions extending through said substrates such that the dug portion is located in positions opposite to said vibrator;

forming said magnet in a third substrate different from said substrates; and

disposing the magnet, which is formed in the third substrate, inside said dug portion and then bonding together said substrates and said third substrate.

44. An angular velocity detector as set forth in claim 43, wherein the magnet formed in said third substrate is disposed in a dug portion formed in said third substrate.

45. A method of fabricating an angular velocity detector as set forth in claim 36, wherein said displacement detection means is fabricated from electrodes located on opposite sides of a space, and wherein said electrodes disposed on said vibrator are formed inside a dug portion via said insulator film after forming said dug portion in said vibrator.

46. A method of fabricating an angular velocity detector as set forth in claim 45, wherein said electrodes disposed on said vibrator are formed inside said dug portion rather than on a surface of said vibrator.

47. A method of fabricating an angular velocity detector as set forth in claim 36, wherein said resilient support bodies are so formed that surfaces of said electrodes disposed on said resilient support bodies are located on a side of said substrate

rather than a surface of said vibrator.

48. A method of fabricating an angular velocity detector, comprising the steps of:

forming a driver electrode and a detection electrode over a first substrate via an insulator film, said driver electrode acting to excite a vibrator to vibrate, said detection electrode acting to detect displacement of the vibrator;

forming a frame, the vibrator, and resilient support bodies using said first substrate, said support bodies acting to poise said vibrator above said frame;

forming electrodes on a second substrate so as to be located in positions opposite to said driver electrode and said detection electrode disposed over said vibrator;

bonding together said frame and said second substrate such that said electrodes are disposed in positions opposite to said driver electrode and said detection electrode;

bonding a third substrate to said frame, said third substrate being provided with a dug portion in a position opposite to said vibrator; and

disposing a magnet as exciting means on at least one of said second and third substrates.

49. A method of fabricating an angular velocity detector as set forth in claim 48, wherein said first substrate is made of a silicon substrate.

50. A method of fabricating an angular velocity detector

as set forth in claim 48, wherein said third substrate is made of a silicon substrate.

51. A method of fabricating an angular velocity detector as set forth in claim 48, wherein said magnet is formed within said dug portion in such a way that the space in said dug portion is left on a side of said vibrator.